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Decomposing Firm-Product Appeal: How important is Consumer Taste?

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Abstract

We develop and structurally estimate a trade model in order to identify the importance of consumer taste for exporters. The model separates taste from quality and productivity (TFPQ) at the firm-product level. Export data by destination countries allow us to identify the level of taste from consumer heterogeneity across destinations. We decompose export revenue into the contribution of taste, quality and costs. We find that taste is very important and explains about 50% of the variation in export revenue. Productivity (TFPQ) differences between firm-products become more prominent than taste in explaining export success only when the cost elasticity of improving quality is high.

JEL Classification: F12, F14

Keywords: tastes, quality, productivity, exports, firm-product [1]

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1 Introduction

Why do some firms export a lot and others do not? What explains the differences in firms' export performance when they export the same product to the same destination? These are important questions since aggregate exports are an important component of country-level GDP and the microeconomic determinants of firms' performance in exporting affect macroeconomic outcomes (Gabaix (2016); Giovanni and Levchenko (2012)).

When firms export their products abroad, many keys to success are at the firm-product level, such as the productivity with which they are produced and the quality offered.[2] But some critical determinants for success are out of firms' hands such as the likes and dislikes of their consumers that are often related to the destination country's habits, culture or stage of development. For example, even if the quality of pork is very high, exports of pork to Muslim countries will have low export success due to the religion in the destination countries. Similarly, the export of horse meat to the UK or the US is unlikely to be a success, even when the quality of the horse meat is very high. These examples illustrate that consumer taste for the same product can vary widely across countries and is likely to matter for trade flows. Thus it is rather surprising that so little attention in the literature has been devoted to the identification of taste as a structural demand parameter.[3]

While for many products, taste differences for the same product across countries may be less extreme than in the above examples, our goal is to find out the importance of taste as an empirical determinant of firms' export performance, relative to other determinants such as cost and quality. We aim to identify taste for a range of industries where the only product attributes available in the empirical data are quantities and values of firm-product-destination export flows. The relatively low level of data requirement that is needed for the identification

[2] Antoniades (2015); Khandelwahl (2010); Gervais (2015); Fan, Li and Yeaple, (2015, 2017); Feenstra and Romalis (2014); Verhoogen (2008); Baldwin and Harrigan (2011).

[3] The importance of taste has been demonstrated with information on product-specific attributes, such as Cosar, Grieco, and Tintelnot (2017) for cars and Atkin (2013) for food.

of our parameters offers the advantage that our methodology can be applied by anyone with access to customs data and firm characteristics. Our paper also contributes to the literature in a more methodological way. In contrast to other papers, we pursue our analysis entirely at the firm-product level. We develop a framework where both the identified demand and supply parameters as well as the decomposition of export revenue is derived at the most disaggregate level of trade flows e.g. at firm-product-country-year level. We thereby fully exploit the multi-product nature of our data. This helps us to distinguish between different types of demand shocks and to control for economies of scope in production. In developing our model we condition on firms' export market participation as earlier work has shown that the main contribution of the demand side lies on the intensive margin.[4,5]

We first develop a trade model where on the demand side, taste for a firm's product enters consumer preferences differently from quality. This raises issues about how we can separate horizontal product differentiation ("taste") from vertical differentiation ("quality") in the utility function, a distinction which, with a few exceptions, has not received much attention in trade theories of monopolistic competition with consumer preferences characterised by love-for-variety.[6]

Vertical differentiation is modeled as any unobservable product characteristic that affects marginal cost and therefore price. It is any demand shifter at the firm-product level that raises both the quantity sold and the willingness-to-pay by all consumers. In contrast, horizontal differentiation is modeled as any unobservable product characteristic that affects demand but does not affect price.[7] This different effect on price is what allows us to empirically separate the

[4]Roberts, Xu, Fan and Zhang (2016) assess the role of firm-level demand heterogeneity in export participation.

[5]By conditioning on export participation we do not consider fixed entry costs as a source of variation in trade decisions which was studied earlier by Aw, Roberts and Xu (2011).

[6]Fajgelbaum, Grossman, Helpman (2011) separate quality from taste using a discrete choice model where consumer consumption is limited to one unit of each product. Cosar et al. (2017) use a random coefficient discrete choice setting to identify the national taste bias for cars. Di Comité, Thisse and Vandenbussche (2014) separate quality from taste in a "love-for-variety" trade model with quadratic utility.

[7]This distinction between vertical and horizontal differentiation largely follows the industrial economics literature (Hotelling (1929), Sutton (1991), Vogel (2008)). Recent research in trade has also embraced a distinction

two types of differentiation.[8] Put differently, while higher quality always shifts out demand in any destination country, taste variation across countries implies that the same quality product can, ceteris paribus, have very different export revenues across destinations. These definitions are congruent with definitions in the industrial organization literature but have never been embedded jointly in a standard trade model.

With the availability of more detailed data containing information on destination-specific demand, we can be more specific in modeling the demand side to tease out part of the variation in export revenue due to consumer tastes. In the previous literature, consumer tastes typically ends up in the residual of any demand function estimation. In contrast to these earlier studies, we do not take a residuals approach since it would be confounding consumer tastes with other potentially unobserved demand and supply shocks and measurement errors. The destination specific information on consumption for each firm-product in the data allows for identification of the consumer taste determinant in export revenues and to distinguish taste from other destination specific effects. Taste in our model is measured by product-destination-year dummy variables in a CES demand equation and explains remaining differences in firm-product performance by destination, after conditioning on price and quality as well as controlling for firm age, destination and product market specific effects such as market size, income, markups as well as competition effects and distribution costs that could vary at the destination and product market levels.[9] The destination specific information in our data also allows our demand elasticities and therefore markups in our model to vary by product and destination.

To separate our measure of quality from consumer tastes, we approximate quality using a control function approach. We proxy intrinsic quality through a polynominal in imported input

between vertical and horizontal differentiation in models of discrete choice such as Khandelwal (2010) and Fajgelbaum et al. (2011) and in quadratic utility models of monopolistic competition such as Di Comité et al. (2014).

[8]To disentangle horizontal from vertical differentiation in this way is not straightforward in models of discrete choice since it requires a demand shifter that affects only quantity sold without affecting price.

[9]This approach is consistent with that of Bernard, Redding and Schott (2010) who introduce a similar horizontal differentiation demand shifter. But in contrast to Bernard et al.(2010) where the role of quality is not considered, our purpose is to distinguish taste from product quality.

prices and income levels of the destination countries. The underlying assumption is that higher quality goods require higher quality inputs with higher prices (Kugler and Verhoogen (2011)) and that higher quality goods are shipped to richer countries (Hallak (2006)).

On the supply side of our model, we allow productivity to vary by product within the firm.[10] In contrast to most other models that embed quality, we do not restrict the correlations among productivity, quality and taste. Therefore high quality products may or may not be liked in the country of destination. Most existing models predict that only the most productive firms can offer higher quality. But in our model, strong taste for a firm's product in one or several destination markets, could compensate for the low productivity of the product to make it still profitable for the firm to purchase high priced inputs and to sell high quality products.

Our empirical analysis is based on micro-data of exports of Belgian firms at the product-level and by country of destination. The data are used to estimate an empirical model of export quantity and export revenue by firm-product-destination.

Armed with our measures of demand elasticities, quality and consumer tastes from estimating the demand equation and productivity from estimating the revenue function, we proceed to the final empirical analysis in which we decompose firm-product export revenue into productivity, quality and tastes to determine their relative importance in export sales variation of exporting firms. Our decomposition results point to demand differences being very important for overall firm-product sales variation. On average we find that productivity, quality and tastes explain 30%, 10% and 50% respectively, of the variation in firm-product export revenues.

In general, taste is always a very important determinant of export revenue. But these decomposition results vary depending on the type of goods and on the destination. Taste matters more for consumption goods relative to intermediate goods and for goods that are exchanged in markets with reference prices. For goods where the cost elasticity of quality is high, the decomposition shows that firm-product productivity is more important than taste.

[10] In contrast to Eckel and Neary (2010) and other models, we do not impose a productivity ladder amongst products within the firm, but we simply allow productivity to vary between products of the same firm.

We find a significant and positive correlation between the minimum quality shipped and the distance to a destination. Similarly, minimum productivity and tastes are also positively correlated with distance. More distant destinations are served with higher quality of goods, higher productivity goods and goods for which the taste is stronger. The empirical importance of taste in the decomposition also varies by destination. An example of two countries where the role of taste in sales variation is very different is China versus North-Amercia. We find quality is very important for Chinese consumers, while taste is a larger source of firm-product sales variation for the North-American consumers.

In general, a failure to account for taste as a demand determinant, results in a serious underestimation of the importance of the demand side and an over-estimation of the supply side importance in explaining firm-product export revenues. Ignoring taste in the decomposition almost doubles the variation explained by productivity relative to demand.

2 Literature Review

Existing research has suggested a number of explanations for differences in firm performance, such as differences in technical efficiency,[11] product quality[12] and the multi-product nature of firms.[13] In the literature on firm heterogeneity following Melitz (2003), marginal cost and quality are isomorphic under CES and monopolistic competition.

More recently, increasing attention has focused on the role of demand (Feenstra and Romalis (2014); Roberts et al. (2016); De Loecker (2011); Foster, Haltiwanger and Syverson (2008)). In particular, Hottman, Redding and Weinstein (2016) use bar codes from scanner data on consumption goods to quantify firm appeal (defined to include both quality and taste). They show that cost and firm appeal have different implications on firm revenue conditional on prices.

[11] E.g. Melitz (2003).

[12] E.g. Schott (2008), Khandelwal (2010); Feenstra and Romalis (2014); Roberts et al. (2016), Aw and Lee (2014, 2017); Di Comité et al. (2014); De Loecker, Goldberg, Khandelwal, and Pavcnik (2016)

[13] E.g. Bernard et al. (2010)); Eckel and Neary (2010); Mayer, Melitz, Ottaviano (2014).

In their paper quality and taste differences are isomorphic and are not distinguished from each other. In their model, marginal cost affects firm revenue through prices, while quality affects firm revenue conditional on prices. Thus if two firms charge the same price, but one firm has a more appealing product (e.g; higher quality) then that firm will generate more sales. De Loecker et al. (2016) use an alternative methodology to separate firm-product productivity from markups and marginal costs. In their model, a control function is used to proxy for quality that includes market shares of the products. However, like Hottman et al. (2016), they do not distinguish the effects of quality from taste.

The current literature on quantifying taste in trade is small. The importance of taste has been demonstrated for a few very specific industries using information on product-specific attributes by Atkin (2013) for food and Cosar et al. (2017) for cars. Atkin (2013) argues that habits from childhood result in taste preferences for certain foods during adulthood. He shows that for India, tastes for locally grown food products explain why consumers continue to buy the same food products even when prices go up. The habit formation in taste suggests that tastes can be persistent over time. He shows that most of variation in taste come from the cross-sectional dimension rather than variation over time. Cosar et al. (2017) demonstrate the importance of taste to explain the home market bias for national brands in consumers' car purchases. Using a discrete choice model, they find that home demand preference is the major driver of the home market advantage.

Our paper deviates from the above papers in that our main goal is to empirically separate consumer tastes from product quality. We follow the industrial organization literature in decomposing the variable that Hottman et al. (2016) calls "firm appeal" into its vertical (quality) and horizontal (taste) components.[14] To that end, it is necessary to estimate a demand function wherein the measures of tastes can be separately identified from our measures of quality.

[14]In order to separate taste from quality, we need to make functional form assumptions regarding demand. However, our empirical measures of taste and quality are consistent with either CES or a quadratic utility function (see Di Comité at al. (2014)).

Our choice of the Dixit-Stiglitz CES demand structure combines strong tractability with flexibility in achieving our goal. In particular, while markups are generally assumed to be constant in the standard CES models, the detailed information in our data enables markups to vary by product and country of destination. A common approach to estimating quality is one in which quality is a function of both prices and market shares (Khandelwal (2010)). We do not take this route because in our framework, market shares are also a function of taste and would confound quality with taste. Instead to separate taste in demand, we apply a control function approach for quality.

In this paper, our main purpose is to identify cross-sectional variation in taste, quality and productivity, not dynamics over time. We use trade data where products are defined at the eight-digit level (CN8). Since CN8 products are defined at a more aggregate level than the scanner data in Hottman et al. (2016), our product definitions are less refined. However, the advantage of our trade data is that we have destination specific information on consumer purchases which allows us to study very different consumers in countries that differ in their development levels, income and preferences. The large variation in international consumer heterogeneity will help us to identify taste differences between them. The destination specific nature of our data also allows us to break down firm-appeal into taste versus quality at the firm-product level. This is an important step forward in the trade literature. Another advantage of using trade data is that CN8 product classifications include exports in intermediate as well as consumer goods. This allows us to assess the role of taste for consumer and intermediate goods separately.

3 Theoretical Framework

In this section, we start with the demand side of the model. While the theoretical model is essentially static, in the empirical counterpart to theory, we allow for dynamics in the evolution of the productivity and demand parameters.

Consumers in country d face a constant elasticity of substitution (CES) utility function:

$$U_d = \left(\sum_{j=1}^{n} \sum_{i=1}^{k} [\lambda_{id}^{\frac{1}{\sigma_{id}-1}} \delta_{ji}^{\frac{1}{\sigma_{id}-1}} q_{jid}]^{\frac{\sigma_{id}-1}{\sigma_{id}}} \right)^{\frac{\sigma_{id}}{\sigma_{id}-1}} \tag{1}$$

where q_{jid} is the quantity of product i produced by firm j that is consumed in country d and $\sigma_{id} > 1$ is the elasticity of substitution between any pair of varieties within a product market i in country d.[15] λ_{id} is an index of demand reflecting the taste of consumers in country d for product i, δ_{ji} reflects consumers' willingness-to-pay (or product quality) for product i produced by firm j. This specification allows for a product-specific component λ_{id} that is common to all firms that export product i, but varies by destination market and year, and a firm-product-specific component δ_{ji} that is common across destination markets.[16] In a standard CES model, the parameter σ typically captures both product differentiation as well as product substitutability. In contrast, the model here separates product differentiation from product substitutability by adding two additional parameters in the utility function. Therefore σ gets a different interpretation than in most CES models since it is now cleaned from horizontal and vertical product differentiation, thus resulting in a finer measure of the elasticity of substitution (σ) compared to other studies.

The CES-demand function and corresponding price index can be expressed as:

$$q_{jid} = \frac{E_d}{P_d} \lambda_{id} \delta_{ji} \tilde{p}_{jid}^{-\sigma_{id}}, \text{ with } P_d = \sum_{j=1}^{n} \sum_{i=1}^{k} \delta_{ji} \lambda_{id} \tilde{p}_{jid}^{1-\sigma_{id}} \tag{2}$$

where E_d represents total expenditure in country d, P_d is the price index for all varieties in country d, and $\tilde{p}_{jid}$ is the price of product i provided by firm j that consumers in country d face

[15]Empirically, we estimate the elasticity of substitution σ_{id} by country d and product market i.

[16]This corresponds to saying that there is an innate taste for Belgian beer in China which can differ from that of the U.S. Any particular beer (i) sold by a firm (j) is assumed to have the same intrinsic quality, independent of destination.

(i.e., the c.i.f. price). Firm level demand in a destination can thus vary due to export prices (inclusive of trade cost), the quality offered (δ) and the local taste (λ) as well as destination specific characteristics like income, local competition and market structure (price index).

Firms are heterogeneous in productivity for each of their products i, ω_{ji}, and product quality, δ_{ji}, and firm j's marginal costs of producing good i, c_{ji}, are decreasing in firm productivity but increasing in product quality so that[17]

$$c_{ji} = W_j \omega_{ji}^{-1} \delta_{ji}^{\gamma}, \quad \gamma > 0 \tag{3}$$

where W_j is the unit price of the bundle of input factors used to produce final output and γ reflects the cost elasticity of consumer valuations of δ_{ji}.[18] c_{ji} thus reflects also the cost of generating higher demand as δ_{ji} is a vertical demand shifter.

Both firm productivity and vertical differentiation affect firms' costs. Under monopolistic competition, firms set their prices, p_{jid}, and earn revenues, r_{jid}, in country d defined as:

$$\begin{aligned} p_{jid} &= \frac{\sigma_{id}}{\sigma_{id}-1} c_{ji} \tau_{id} \\ r_{jid} &= \frac{E_d}{P_d} \Big(\frac{\sigma_{id}}{\sigma_{id}-1}\Big)^{1-\sigma_{id}} \lambda_{id} W_j^{1-\sigma_{id}} \omega_{ji}^{\sigma_{id}-1} \delta_{ji}^{1-(\sigma_{id}-1)\gamma} \tau_{id}^{1-\sigma_{id}} \end{aligned} \tag{4}$$

where $\tau_{id} \geq 1$ captures all exchange rate effects, tariffs and shipping costs between Belgium and the destination country d in a particular product market i . The price equation suggests that product quality affects price through costs, while taste (λ) does not affect price and only affects quantity sold (see equation (3)) and hence, revenue. In this way, we are able to separately identify taste from quality as a structural parameter of the model since the taste parameter λ enters the revenue equation but not the price equation. Moreover, we define the destination

[17]That is, firms pay extra costs to raise consumers' willingness-to-pay related to higher quality or investments to build a customer base. Eaton, Eslava, Jinkins, Krizan and Tybout (2015) show that producers who are interested in a particular foreign market devote resources to identifying potential buyers there.

[18]Empirically we do not observe output quality (δ) but will proxy it amongst others by input prices of imported material inputs as in Kugler and Verhoogen (2011) and others.

specific markup as $\sigma_{id}/(\sigma_{id}-1)$.

4 Data

Our data consist of Belgian manufacturing firms for the period 1998-2005 with information on firms exports by product and by destination and firm imports by product and country of origin. The Belgian export data has been handled at the National Bank of Belgiums (NBB) Trade Database, which covers the entire population of recorded trade flows.[19] The trade data are recorded at the year-firm-product-country level, i.e. they provide information on firm-level trade flows by 8-digit Combined Nomenclature (CN8) product and by country.[20]

The NBB trade data are merged with balance sheet data on firm-level characteristics such as total sales, wages, material inputs, capital, employment, multi-products and other firm-level characteristics.

The reason for choosing to study the period 1998-2005 is that the threshold for firms to be considered as exporters changed over time. This threshold at firm-product level was raised in 1998 from 104,115€ to 250,000€ but did not change afterwards until 2006. However, during the period of our analysis, the HS6 product classification altered three times. To address the changes in product classifications over time (Table B-7), we concord the product codes along the lines of Van Beveren, Bernard and Vandenbussche (2012).[21] We then focus our analysis on those product codes that either did not change over the period that we consider or that had a one-to-one product code change. We thus disregard growing and declining product code

[19] We exclude transactions that do not involve a "transfer of ownership with compensation". This means that we omit transaction flows such as re-exports, the return, replacement and repair of goods and transactions without compensation, e.g. government support, processing or repair transactions, etc.

[20]The CN8-product classification is similar to the HS6 classification for the first 6 digits but offers more product detail in the last two digits. Changes in HS6 and CN8 classifications can affect product code changes as shown in Table B-7.

[21]Instructions for concordance of trade classifications over time can be found here: https://www.sites.google.com/site/ilkevanbeveren/Concordances and are explained in Van Beveren, Bernard and Vandenbussche, (2012), "Concording EU Trade and Production data over Time", NBER working paper series 18604.

families. In doing so we lose about 20% of export value in our data, but this ensures that our data are cleaned of product code changes which could otherwise result in misinterpretations on product scope at firm-level. This prevents measurement bias when we construct our measure of firm-product productivity where we allocate raw material inputs over domestic and exported products.

In our analysis we focus on those industries with the top eight export shares. Export shares by industry range between 15% for "motor vehicles" and 5.7% for "Electrical&Electronic". Our data comprise both consumption goods such as "Food", as well as more intermediate products, such as "Chemicals" and "Plastics". Together the industries that we study represent over 60% of aggregate Belgian exports. Appendix Table B-1 documents the number of observations per industry and per region, where each observation is a firm-product-destination export flow. Table B-8 reports the level of product aggregation at which each of the parameters are measured empirically.

5 Empirical Model

In this section we lay out our empirical identification strategy on how to identify the most important parameters from our model. We start with the demand parameters, leaving the estimation strategy for the cost and productivity parameters for the next subsection. We add an additional subscript t in the notation of the equations to indicate the panel dimension of the data. Following Roberts et al. (2016), we estimate the demand function for all products i at CN8 level belonging to the same product market to get the estimates of consumer tastes, λ_{idt} and product quality, δ_{jit}.[22] Given that our model is based on multi-product firms, the number of varieties i, can differ from the number of firms, j.

[22] A product market is defined here at HS2 level to get sufficient observations and variation for the estimation of σ.

5.1 Demand Estimation

Based on the theoretical framework, the CES utility implies that the demand function for variety i of firm j in country d is:

$$
\begin{aligned}
q_{jidt} &= \frac{E_{dt}}{P_{dt}} \lambda_{idt} \delta_{jit} \tilde{p}_{jidt}^{-\sigma_{id}} exp(\varepsilon_{jidt}), \quad \text{with } \ P_{dt} = \sum_{j=1}^{n} \sum_{i=1}^{k} \delta_{jit} \lambda_{idt} \tilde{p}_{jidt}^{1-\sigma_{id}} \\
q_{jidt} &= \frac{E_{dt}}{P_{dt}} \lambda_{idt} \delta_{jit} p_{jidt}^{-\sigma_{id}} \tau_{dt}^{-\sigma_{id}} exp(\varepsilon_{jidt})
\end{aligned} \tag{5}
$$

where $\tilde{p}_{jidt}$ is the c.i.f. price and $p_{jidt} = \frac{\tilde{p}_{jidt}}{\tau_{dt}}$ is the f.o.b. price,[23] ε_{jidt} is the random demand shock. E_{dt} is the total expenditure in the product market in country d and year t and P_{dt} is the aggregate price index. Accordingly, we estimate the demand function as follows:

$$
\begin{aligned}
\ln q_{jidt} &= \ln E_{dt} - \ln P_{dt} - \sigma_{id}(\ln p_{jidt} + \ln \tau_{dt}) + \ln \delta_{jit} + ln\lambda_{idt} + \varepsilon_{1jidt} + \varepsilon_{2jidt} \\
&= \beta_{gdp} \ln GDP_{dt} + \beta_{\tau} \ln Dist_d - \beta_d \ln p_{jidt} + \ln \delta_{jit} + ln\lambda_{kgt} + \nu_{jidt} + u_{jidt} \\
&\text{where } \ \varepsilon_{1jidt} + \varepsilon_{2jidt} + (ln\lambda_{idt} - ln\lambda_{kgt}) = \nu_{jidt} + u_{jidt}, \ \text{ and } \ i \in k, d \in g
\end{aligned} \tag{6}
$$

where in the first line ε_{1jidt} accounts for any unobserved demand shock correlated with price and ε_{2jidt} is white noise. Unobserved demand shocks could comprise perceived quality differences across destinations which would be correlated with the destination specific price. We expect these perceived quality differences to be small. Bilateral correlations of price rankings of a set of similar products are reported to be high, suggesting that firms ship similar quality around the world (Di Comité et al. (2014)). However, we cannot exclude a correlation between ϵ_{1jidt} and p_{jidt} which is why an OLS estimation of equation (6) would bias results.

In equation (6), $\ln GDP_{dt}$ captures the market size effect on the demand for firm-products in the destination countries and $\ln Dist_d$ is the distance (in log form) between the destination

[23]In the data set, we only observe the f.o.b. prices. For simplification, we assume that trade costs do not vary across products to any given destination, that is, $\tau_{id} = \tau_d$ for $i = 1, 2, .., k$.

country and Belgium which controls for the bilateral trade cost, τ_d.[24] Coefficient $\beta_d = \sigma_{id}$ reflects the elasticity of substitution across varieties in country d. The variable q_{jidt} is quantity sold of firm j's product i at time t and p_{jidt} is the f.o.b. price that firm j charges for its product i in country d and year t.[25] Product i in our data set is defined as the CN8 level. To simplify the analysis, we group countries(d) into regions(g) and aggregate consumer tastes to 4-digit HS classification(k).[26] Consumers' tastes are then aggregated and represented as $ln\lambda_{kgt}$. Without this aggregation we do not have enough firms to estimate consumer taste at the CN8 level by destination. The deviation of the country-level consumer tastes from the mean consumer tastes in the region ($ln\lambda_{idt} - ln\lambda_{kgt}$) and the unobserved demand shock (ε_{1jidt}) can be put together and decomposed into two components, ν_{jidt} and u_{jidt}, where the first component is observed by the firm before making the price/quantity decisions and the second component is a transitory shock.

Since ν_{jidt} would generally lead firms to change prices i.e., $E(p_{jidt}\nu_{jidt}) \neq 0$, estimation of equation (6) using OLS yields biased coefficients on price because of the endogeneity of prices. Under this setting, two-stage least squares (2SLS) estimation can be used to obtain consistent estimates of the price coefficients. Good instruments for price are variables that shift the short run supply curve of the firm. We instrument for price with the average prices of product i that the firm exports to other countries. This instrumentation strategy relies on the assumption that unobserved demand shocks on product i of the firm are independent across destination countries which then ensures that our instrument is uncorrelated to the error term. However, we cannot exclude that shocks are correlated in neighbouring countries. Therefore we also verify results under an alternation instrumentation strategy where we define the instrument

[24]Here we include distance as a destination specific transport cost. Later, in section 6.1, we engage in a normalization which additionally accounts for product specific transport costs (τ_{id}).

[25]Because the unit values across different CN8 products are not always comparable, we normalize lnp by taking the deviation of the firm's prices from the average price across all firms selling the same (CN8) product and dividing it by the standard deviation of the prices.

[26]We define ten different regions for this purpose. Australia and New Zealand(AU), China(CN), East Asia(EA), Eastern Europe(EE), Middle East(ME), North America(NA), South Asia(SA), South America(SAM), Sub-Saharan Africa(SSA), Western Europe(WE).

as the average price of the product i going to countries outside the region of the destination country. By doing so, we lose around 26% of observations. The correlation between the quality index estimated from the original IV and the alternative one is 0.99, suggesting that results are not sensitive to the instrument chosen.

Firm-product quality ($ln\delta_{jit}$) is intrinsic to a product but unobserved in the data.[27] If the unobserved firm-product quality is correlated with output price (lnp_{jidt}) then an OLS estimation of equation (6) generates inconsistent parameters. To deal with this issue we use a control function approach by replacing the unobserved $ln\delta_{jit}$ with observed input costs of quality and the income level of the destination country by using respectively firm import prices and per capita GDP of the destination country both of which are correlated with product quality. We normalize import prices of inputs by their CN8 product mean to control absolute price differences across products. Firms are likely to export high-quality products to high-income countries (Schott (2004)). Moreover, producing high-quality products may require high-quality inputs (Kugler and Verhoogen (2011) and Fan et al. (2015)). If high-quality inputs cost more, the imported prices of a firm are a proxy variable for product quality. The other proxy for product quality is GDP per capita of the destination countries, a variable that is highly correlated with the consumption of high quality products (Bils and Klenow (2001) and Hallak (2006)).

Since a firm-product pair can be exported to several destinations, we use the sales share of the product exported to country d over the total export of the firm-product pair as the weight to construct the firm-product weighted per capita GDP. That is, $PCGDP_{jit} = \sum_d s_{jidt} \times PCGDP_{dt}$ where s_{jidt} is the ratio of firm j's sales revenue on product i that is exported to country d over firm j's total export sales on product i, and $PCGDP_{dt}$ is country d's per capita GDP in year t. Similarly, we construct a firm-level import price index by calculating the weighted sum of import prices of each imported product within a firm.[28]

[27] See *The Economist*, July 1 2017, p. 25, arguing that firms ship similar quality around the globe

[28] Here $IMP_{jt} = \sum_z \sum_o s_{jzot} \times IMP_{jzot}$ where s_{jzot} is the import share of firm j's total imports that come

Therefore, $ln\delta_{jit}$ can be represented by a function of weighted per capita GDP and firm import price, $f(\ln PCGDP_{jit}, \ln IMP_{jt})$. It should be noted that this weighted approach implies that in the end our quality measure is independent of any particular destination, but does take into account the income levels of all the destinations it is sent to. By proxying $ln\delta_{jit}$ as a second-order polynomial approximation, equation (6) can be re-written as:

$$\begin{aligned}\ln q_{jidt} = \beta_{gdp}\ln GDP_{dt} + \beta_{\tau}\ln Dist_{d} - \beta_{d}\ln p_{jidt} + D_{kgt} + \big[a_1\ln PCGDP_{jit} + a_2\ln IMP_{jt} \\ + a_3(\ln PCGDP_{jit})^2 + a_4(\ln IMP_{jt})^2 + a_5(\ln PCGDP_{jit} \times \ln IMP_{jt})\big] + \nu_{jidt} + u_{jidt} \quad (7)\end{aligned}$$

where j denotes firm, i denotes CN8-products, d denotes destination countries, t denotes year, k denotes (HS4)product categories, and g denotes regions. D_{kgt} is a set of dummy variables representing the combination of (HS4)product-region-year to measure taste (λ_{kgt}).[29]

By using 2SLS, the estimation of the demand function in equation (7) allows us to empirically identify three important parameters e.g. the elasticity of demand $\hat{\sigma}_{id} = \beta_d$, the (HS4)product-region consumers' taste $ln\hat{\lambda}_{kgt} = \hat{D}_{kgt}$, and the firm-product quality index $ln\hat{\delta}_{jit}$ by[30]

$$ln\hat{\delta}_{jit} = \hat{a}_1\ln PCGDP_{jit} + \hat{a}_2\ln IMP_{jt} + \hat{a}_3(\ln PCGDP_{jit})^2 + \hat{a}_4(\ln IMP_{jt})^2 + \hat{a}_5(\ln PCGDP_{jit} \times \ln IMP_{jt})$$

from good z imported from country o and IMP_{jzot} is the import price of good z coming from country o.

[29]We do not include additional fixed effects (country or product FE) in equation (7) since our measure of consumer taste λ, would then be measured as an index relative to a base group, rendering the interpretation very difficult and not useful for the decomposition later on.

[30]The estimated consumers' taste ($ln\hat{\lambda}_{kgt}$) may still capture some market size effect (after controlling for GDP in its estimation). This will be controlled for in section 6.1 where we perform a normalization in which we further "clean" λ by normalizing each firm-product-destination export revenue flow by the average firm export revenue in the same product-destination market to control for markups, market size and competition effects at the product market level. The advantage is that in the decomposition we then do not need to control for market size and markups additionally.

5.2 Cost and Revenue Estimation

We start by defining firm j's short-run marginal costs (in log form) of product i in year t as:

$$lnc_{jit} = \gamma_w lnW_{jt} + \gamma_{pm} lnIMP_{jt} + \gamma_k lnk_{jt} + \gamma_q lnq_{j-it} + \gamma_\delta ln\hat{\delta}_{jit} + \gamma_t D_t - \omega_{jit} + \epsilon_{jit} \quad (8)$$

where W_{jt}, IMP_{jt} and k_{jt} are the wage rates, firm-level import price index[31] and capital stock for firm j in year t, respectively, $q_{j-it} = \sum_{l \neq i, l \in \Omega_{jt}} q_{jlt}$ represents the total sales[32] of all of the firm's products except product i, ω_{jit} represents firm j's productivity in the production of product i in year t, D_t is a set of year dummy variables and ϵ_{jit} is an i.i.d. cost shock. Since the manufacture of products with higher product quality involves higher marginal costs, we allow the firm's marginal costs to be a function of product quality, $\hat{\delta}_{jit}$, which is partly based on import prices of material inputs. Note that $\hat{\delta}_{jit}$ has been estimated in the previous stage when estimating the demand equation (7).

We include lnq_{j-it} in the marginal cost equation to capture the magnitude of production complementarities or technological distance between the firm's product pairs. If firms engage in joint-production of products,[33] where they share the same inputs across multiple products, an increase in the production of one product provides free inputs for the other product (economies of scope). In our data, we find that for every industry these economies of scope are significant at the 1% level, suggesting that the marginal cost of production for a given product is not the same for a single versus a multi-product firm. For the estimation of productivity, we utilize the multi-product cost function instead of the single product firm allocation of inputs to outputs.[34] The alternative of assuming similar marginal cost of production for a given product of a single

[31] The correlation between wages and the imported input price index does not exceed 0.27.

[32] Total sales is measured as value of sales rather than physical output since different products have different units of quantity.

[33] For instance, the processing of crude oil as an input simultaneously yields both gasoline and lubricants.

[34] Dhyne, Petrin, Warzynski (2014) apply a similar approach to estimating firm-product level marginal cost for multi-product firms.

product firm compared to a multi-product firm is likely to introduce measurement error due to the presence of scope economies in production. Assuming that firms face a monopolistically competitive market, firm j's optimal price of product i in country d and year t is

$$ln\tilde{p}_{jidt} = ln(\frac{\sigma_{id}}{\sigma_{id}-1}) + lnc_{jit} + ln\tau_{dt}.$$

Using the demand and pricing equations, we can express the log of the firm's revenue as:

$$\begin{aligned} lnr_{jidt} &= ln(\frac{E_{dt}}{P_{dt}}) + ln\hat{\delta}_{jit} + ln\hat{\lambda}_{kgt} + \varepsilon_{jidt} + (1-\sigma_{id})ln\tilde{p}_{jidt} \\ &= ln(\frac{E_{dt}}{P_{dt}}) + ln\hat{\delta}_{jit} + \varepsilon_{jidt} + (1-\sigma_{id})\Big[ln(\frac{\sigma_{id}}{\sigma_{id}-1}) + \gamma_w lnW_{jt} + \gamma_{pm} lnIMP_{jt} + \gamma_k lnk_{jt} \\ &+ \gamma_q lnq_{j-it} + \gamma_\delta ln\hat{\delta}_{jit} + \gamma_t D_t - \omega_{jit} + \ln\tau_{dt} + \epsilon_{jit}\Big] + \ln\hat{\lambda}_{kgt} \qquad (9) \end{aligned}$$

The firm's revenue will depend on the observable cost factors, lnW_{jt}, $lnIMP_{jt}$ and lnk_{jt}, characteristics of multi-product firms, q_{j-it}, firm demand index, $ln\hat{\delta}_{jit}$, and productivity shocks, ω_{jit}. Rearranging the revenue equation and recycling the estimated parameters from the demand equation in (7), to control for quality ($\hat{\delta}_{jit}$), taste ($\hat{\lambda}_{kgt}$) and markups ($\sigma_{id}/(\sigma_{id}-1)$) we obtain

$$\begin{aligned} \frac{1}{1-\hat{\sigma_{id}}}\big(lnr_{jidt} - ln\hat{\lambda}_{kgt}\big) - ln(\frac{\hat{\sigma}_{id}}{\hat{\sigma}_{id}-1}) &= \gamma_{gt} + \gamma_{gdp} lnGDP_{dt} + \gamma_w lnW_{jt} + \gamma_{pm} lnIMP_{jt} + \gamma_\tau \ln Dist_d \\ &+ \gamma_k lnk_{jt} + \gamma_q lnq_{j-it} + (\frac{1}{1-\hat{\sigma}_{id}} + \gamma_\delta) ln\hat{\delta}_{jit} - \omega_{jit} + e_{jidt} \end{aligned} \qquad (10)$$

where $\gamma_{gt} = \gamma_g D_g + \gamma_t D_t$ is a set of region and time dummy variables capturing all region and time-varying variables on the demand and supply sides. $e_{jidt} = \varepsilon_{jidt} + \epsilon_{jit}$ includes the demand and cost unobserved shocks. If the unobservable firm productivity (ω_{jit}) is correlated with the observable cost factors (W_{jt} and IMP_{jt}) and firm quality index (δ) then OLS of equation (10) estimation generates inconsistent parameters. To deal with this issue we follow Levinsohn and

Petrin (2003)[35] by replacing the unobserved ω_{jit} with a control function[36] in material usage and capital stock respectively ($f(lnm_{jit}, lnk_{jit})$). Later as a robustness check, we correct for varying markups at firm-product level and use a different allocation rule than the one we use here.

In the first stage, we estimate the revenue function:

$$\begin{aligned}\frac{1}{1-\hat{\sigma_{id}}} lnr_{jidt} - \frac{1}{1-\hat{\sigma_{id}}} ln\hat{\lambda}_{kgt} - ln(\frac{\hat{\sigma}_{id}}{\hat{\sigma}_{id}-1}) &= \gamma_{gt} + \gamma_{gdp} lnGDP_{dt} + \gamma_w lnW_{jt} + \gamma_{pm} lnIMP_{jt} + \gamma_\tau \ln Dist_d \\ &+ \gamma_q lnq_{j-it} + (\frac{1}{1-\hat{\sigma_{id}}} + \gamma_\delta) ln\hat{\delta}_{jit} \\ &+ \phi(lnk_{jit}, lnm_{jit}, lnk_{jt}) + e_{jidt} \qquad (11)\end{aligned}$$

where $\phi(lnk_{jit}, lnm_{jit}, lnk_{jt}) = \gamma_k lnk_{jt} - \omega_{jit}(lnk_{jit}, lnm_{jit})$ comprises of lnk and firm-product productivity in the revenue function. By treating ϕ as a polynomial we can estimate this equation using ordinary least squares and construct the fitted value $\hat{\phi}_{jit}$. In the second stage, we can then separately recover the productivity shocks and marginal cost components based on the productivity evolution equation:

$$\omega_{jit} = h(\omega_{jit-1}) + \epsilon_{jit}$$

where ϵ_{jit} is an i.i.d. shock. Rearranging the productivity evolution equation, we get

$$\begin{aligned}\hat{\phi}_{jit} &= \gamma_k lnk_{jt} - h(\omega_{jit-1}) - \epsilon_{jit} \\ &= \gamma_k lnk_{jt} - h(\gamma_k lnk_{jt-1} - \hat{\phi}_{jit-1}) - \epsilon_{jit}\end{aligned}$$

[35] The use of a control function may introduce measurement error as shown by Gandhi, Navarro and Rivers (2017). However, as long as the use of the control function does not alter the productivity ranking between firm-products, this will not affect the decomposition results which is what we are ultimately after.

[36] The data on input usage is only available at the firm level. Following Foster et al. (2008), we assign the inputs across the outputs according to the product's revenue share in the firm. This allocation mechanism is only valid when markups are constant across products. Since our markups vary across products, for robustness we also experiment with a new allocation rule whereby export revenue shares are first deflated with the product-specific markup before assigning inputs to outputs.

By assuming a functional form for the h function, we can estimate the equation using nonlinear least squares and recover the parameters γ_k and the parameters of the productivity evolution function h. Given these estimates, the productivity shock for each firm-product and year can be retrieved as:

$$\hat{\omega}_{jit} = \hat{\gamma}_k lnk_{jt} - \hat{\phi}_{jit} \tag{12}$$

The firm-product productivity obtained from (12) can be regarded as a TFPQ measure of firm-product productivity since it is not contaminated by price effects. Excluding the imported input price index from (8) does not have a significant influences on the ω estimation e.g. the scale of productivity changes but the correlation between the original ω and the new ω measures is around one.[37]

6 Decomposition of Firm-Product Export Revenue

6.1 Decomposition by Product

In the previous section we identified quality (δ_{ijt}), taste (λ_{kgt}) and TFPQ (ω_{ijt}). In this section, we assess the relative importance of demand versus supply determinants in export revenue. We are interested in the contributions of firm productivity, product quality and consumer tastes to the export revenue at firm-product level.[38] In particular, we want to know how important taste is as a distinct and separate determinant of export flows. For this purpose we engage in a decomposition where we isolate the contributions of productivity, quality and taste as determinants of firm export revenues.

Before we embark on the decomposition we rewrite equation (9), to get firm j's export

[37] In the revenue equation, the correlation between IMP and $\hat{\delta}$ is 0.6. While this does not affect the estimated values of $\hat{\delta}$, it may affect the estimation of ω

[38] In this section we look at data at firm-product level so we reduce the data by one dimension e.g. we do not consider the destination specific information here, but pursue a decomposition by destination in the next section.

revenues on product i in destination country d and year t:

$$\begin{aligned}
r_{jidt} &= \Big(\frac{E_{dt}}{P_{dt}}\Big)\delta_{jit}\lambda_{kgt}\bigg[\Big(\frac{\sigma_d}{\sigma_{id}-1}\Big)c_{jit}\tau_{dt}\bigg]^{1-\sigma_{id}} \\
&= \Big(\frac{E_{dt}}{P_{dt}}\Big)\Big(\frac{\sigma_{id}}{\sigma_{id}-1}\Big)^{1-\sigma_{id}}\tau_{dt}^{1-\sigma_{id}}\delta_{jit}\lambda_{kgt}\bigg[\underbrace{INP_{jt}^{\gamma_{inp}}k_{jt}^{\gamma_k}q_{j-it}^{\gamma_q}\delta_{jit}^{\gamma_\delta}\omega_{jit}^{-1}}_{c_{jit}}\bigg]^{1-\sigma_{id}}
\end{aligned}$$

where $INP_{jt}^{\gamma_{inp}} \equiv W_{jt}^{\gamma_w}IMP_{jt}^{\gamma_{pm}}$ represents the firm-level input prices that combines firm wages and the imported input price index in the cost function.

Then we normalize the export revenue to the mean level in each destination to account for any destination and product market size effects that are common to all firms shipping the same product to the same destination which may also affect firm export revenue. The normalized export revenue then becomes:

$$\begin{aligned}
\tilde{r}_{jidt} &= r_{jidt}/\bar{r}_{idt} \\
&= \delta_{jit}\lambda_{kgt}\bigg[\underbrace{INP_{jt}^{\gamma_{inp}}k_{jt}^{\gamma_k}q_{j-it}^{\gamma_q}\delta_{jit}^{\gamma_\delta}\omega_{jit}^{-1}}_{c_{jit}}\bigg]^{1-\sigma_{id}} = \delta_{jit}^{(1+(1-\sigma_{id})\gamma_\delta)}\lambda_{kgt}\bigg[INP_{jt}^{\gamma_{inp}}k_{jt}^{\gamma_k}q_{j-it}^{\gamma_q}\omega_{jit}^{-1}\bigg]^{1-\sigma_{id}}
\end{aligned} \tag{13}$$

where $\bar{r}_{idt}$ is the average export revenue across firms in destination d and year t at the product-level. This normalization accounts for many remaining factors at destination and product-destination level that could contaminate the results of the decomposition. The normalization controls for destination-specific markups, market size effects and product-specific transport costs. The normalization also accounts for product-specific transport costs (τ_{id}) and for market size effects that may otherwise affect our measure of taste. The normalization then ensures that we then do not have to include market size, markups and transport costs as additional determinants in the decomposition. Arguably, the normalization does not entirely free our taste measure from measurement error. There are still two types of measurement errors that can arise. Measurement error that is relatively harmless for our purposes is the one that introduces bias in the level of taste. Since our ultimate interest lies in a decomposition in which we determine the percentage variation explained by each of the structural parameters, it is not the levels of our estimates that affect the outcome of the decomposition, but the cross-sectional variation in the estimated parameters. Therefore in our estimation we worry mostly about the type of measurement error that affects the ranking of taste across products.

While the normalization in equation (13) controls for markups, the elasticity of substitution (σ_{id}) still affects the decomposition in another way. This can be seen from equation (13) where σ_{id}, which is destination specific, still occurs as a power coefficient. It affects the contributions of δ, ω, and input prices to export revenue, even though these variables by themselves do not vary by destination. Thus σ_{id} affects the elasticity of export revenue with respect to any cost increment. In high σ-markets this will result in a large reduction of export revenue, while in a low σ-market, a rise in production costs will imply a smaller loss of export revenue. Since in this section we pursue a decomposition of export revenue at firm-product level, we first need to aggregate export revenues across destination markets. The derivations are shown in Appendix A.

We are now ready to perform a decomposition of export revenue at the most disaggregate level possible e.g. at firm-product level. This decomposition is in the spirit of Hottman et al. (2016), but whereas they pursued it at firm-level, we contribute to the literature by pursuing a decomposition where we explicitly account for product differences within firms. Equation (A.1) in the Appendix shows that firm-product revenue can be decomposed in eight separate determinants: the variation of product quality and consumer tastes across all destinations (B_{jit}), the number of destinations that the product is exported to (N^d_{jit}), firm-level input prices (INP_{jt}), total export sales of all of the firm's products except product i (q_{j-it}), firm capital stock (K_{jt}), firm-product productivity (ω_{jit}), firm-product quality ($\tilde{\delta}_{jit}$) and destination and product specific consumer tastes ($\tilde{\lambda}_{jit}$).

Following Hottman et al. (2016), we regress each component of the right-hand side of equation (A.1) on lnr_{jit} to get the contribution of each component of firm-product export revenue on firm-product export revenues. This is given in equation (14).

$$\begin{aligned}
lnB_{jit} &= \beta_B lnr_{jit} + \varepsilon^{b}_{jit} \\
lnN^{d}_{jit} &= \beta_N lnr_{jit} + \varepsilon^{n}_{jit} \\
\gamma_{inp} lnINP_{jt} &= \beta_W lnr_{jit} + \varepsilon^{inp}_{jit} \\
\gamma_k lnk_{jt} &= \beta_k lnr_{jit} + \varepsilon^{k}_{jit} \\
\gamma_q lnq_{j-it} &= \beta_q lnr_{jit} + \varepsilon^{q}_{jit} \\
ln\widetilde{\lambda_{jit}} &= \beta_\lambda lnr_{jit} + \varepsilon^{\lambda}_{jit} \\
ln\widetilde{\delta_{jit}} &= \beta_\delta lnr_{jit} + \varepsilon^{\delta}_{jit} \\
-ln\omega_{jit} &= \beta_\omega lnr_{jit} + \varepsilon^{\omega}_{jit} \qquad (14)
\end{aligned}$$

Different from Hottman et al. (2016), we use predicted rather than actual export revenues in the decomposition. This implies that the residual variation is not included as an additional component in the decomposition. A first reason is that our identification of demand variables differs. While Hottman et al. (2016) measure “firm appeal” from the residual of the demand function, we have taken a different approach. Since we do not take a residuals approach to capture taste and quality, we have disregarded the residual term arising from the demand estimation. The export revenues in equation (A.1) do include the residual from the revenue equation, which may include unobservable demand and cost shocks that for data reasons or other, we cannot account for. For the food industry for example, our model in equation (A.1) explains 70% (R-squared) of the overall variation in export revenues. Our use of predicted revenues than implies that the regression coefficients arising from estimation of equation (14) should be interpreted as “the percentage variation of the revenue explained by the model”. Important to realise is that the use of predicted revenues does not affect the relative importance of productivity, quality and taste in the decomposition, which is what we are after. Also for the other industries, the average variation explained by our model is close to 70%. Third, the regression coefficients arising from equation (14) should sum to one. Using the predicted revenues guarantees that this is the case.

Our main interest here lies in the β's on ω, δ and λ and less on all the other individual control variables in the decomposition. For convenience, we sum all the control variables in one variable T and report the regression coefficient on the term $lnT_{jit} = lnB_{jit} + lnN^d_{jit} + \gamma_{inp} lnINP_{jt} + \gamma_q lnq_{j-it} + \gamma_k lnk_{jt}$ such that the regression coefficient on the summed term T corresponds to the sum of the regression coefficients on the control variables :

$$\beta_T = \beta_B + \beta_N + \beta_W + \beta_q + \beta_k$$

and since β's sum to one:

$$\beta_\omega + \beta_\delta + \beta_\lambda + \beta_T = 1$$

we can read of the contribution of productivity ω, quality δ and taste λ and other controls as determinants of normalized export revenue variation as percentages.

6.2 Decomposing by Region

In this section, we analyze the contribution of product quality, consumer tastes and productivity to the variation in export revenue at the firm-product-region level. Based on equation (A.1) derived in Appendix A, we calculate firm j' export revenues on product i across markets within region g as:

$$lnr_{jigt} = lnN^d_{jigt} + \big(\frac{1}{1-\sigma_{id}} + \gamma_\delta\big)ln\delta_{jit} + \big(\frac{1}{1-\sigma_{id}}\big)ln\lambda_{kgt} - ln\omega_{jit}$$
$$+ \gamma_{inp}lnINP_{jt} + \gamma_k lnk_{jt} + \gamma_q lnq_{j-it} \tag{15}$$

where $lnr_{jigt} \equiv \sum_{d\in g} ln\tilde{r}_{jidt}$ is the aggregated export revenue across all destination countries within region g for firm j's product i and N^d_{jigt} is the number of destination countries that the firm-product pair export to in region g. Since the demand elasticity (σ_{id}) and consumer tastes (λ_{kgt}) are constant within the firm-product-region-year combination, we do not need to construct the aggregated index for product quality and consumer tastes.

We then regress each component of the right-hand side of equation (15) on lnr_{jigt} to get the contribution of each component of firm-product-region export revenue on firm-product-destination export revenues. The "decomposition by region" below differs from the "decomposition by product" in equation (14) in the sense that we now no longer need term B_{jit}. Since the data are now at firm-product-region level, the decomposition by region no longer needs to consider the variation of demand parameters across destinations. The decomposition therefore now consists of seven determinants instead of eight.

$$lnN^d_{jigt} = \alpha_N lnr_{jigt} + \varepsilon^n_{jigt}$$
$$\gamma_{inp}lnINP_{jt} = \alpha_W lnr_{jigt} + \varepsilon^{inp}_{jigt}$$
$$\gamma_k lnk_{jt} = \alpha_k lnr_{jigt} + \varepsilon^k_{jigt}$$
$$\gamma_q lnq_{j-it} = \alpha_q lnr_{jigt} + \varepsilon^q_{jigt}$$
$$\big(\frac{1}{1-\sigma_{id}}\big)ln\lambda_{kgt} = \alpha_\lambda lnr_{jigt} + \varepsilon^\lambda_{jigt}$$
$$\big(\frac{1}{1-\sigma_{id}} + \gamma_\delta\big)ln\delta_{jit} = \alpha_\delta lnr_{jigt} + \varepsilon^\delta_{jigt}$$
$$-ln\omega_{jit} = \alpha_\omega lnr_{jigt} + \varepsilon^\omega_{jigt}$$

and given that α's sum to one, we get

$$\alpha_\omega + \alpha_\delta + \alpha_\lambda + \alpha_T = 1$$

where $\alpha_T \equiv \alpha_N + \alpha_W + \alpha_q + \alpha_k$ and when we take the decomposition to the data, every regression coefficient α allows us to read of the percentage contribution of each determinant in the decomposition to the firm-product export revenues across destinations.

7 Results

7.1 Summary Statistics and level of Aggregation

Earlier studies using similar type of trade data, have identified supply versus demand determinants but at firm-level and without a decomposition of horizontal and vertical differentiation in demand. In this paper we take a different approach by developing and estimating a model at the more disaggregate firm-product level. A first look at the data can tell us whether this more disaggregated level of analysis is relevant. Our data consist of 51,449 firm-product observations and 112,066 firm-product-destination observations. Table B-1 in the appendix shows the total firm-product observations by industry and by region. In Table 1, we run a simple OLS regression of export prices and quantities on firm-FE which explains 52% of data variation on export prices and 41% of data variation in export quantities. Thus while firm-level factors are important, it misses more than half of the data variation.

Next we run an alternative OLS regression with firm-(CN8)product fixed effects. Firm-product FE seem to explain more of the data variation e.g. 75% of the variation in export prices and 59% of the variation in export quantities. Thus, moving from firm FE to firm-product FE explains substantially more of the data variation than firm-FE or product FE in isolation. Empirically, the importance of the product-destination factors also becomes apparent from Table 1. Product-country FE by themselves explain 50% of export price variation and around 37% of export quantity variation in the data.

We thus conclude from Table 1 that the level of aggregation at which the structural model has been developed e.g. in terms of firm-product productivity and firm-product quality and product-country taste appears more appropriate to explain the data variation than if all variables were defined at firm-level. The panel dimension of the data appears less important which can be seen from the low R-squares when only inserting year fixed effects as shown by the last row in Table 1. Consequently, we mainly focus on the cross-sectional variation in the data, even though are parameters are estimated in a time-varying way.

7.2 Estimation of Demand

Table 2 reports the estimated elasticity of demand(σ_{id}) for each (HS2) industry and region. The elasticity of demand varies mainly across industries and less so across regions with mean values by industry ranging between 1.7 for food to 4.7 for Iron & Steel. The last two columns of Table 2 report the mean value and standard deviation of the elasticities of demand across industries within each region. Western Europe(WE) and China(CN) have the highest elasticities of demand for Belgian export products with the average elasticities 3.93 and 3.73, respectively. North America(NA) and South Asia(SA) have the lowest average elasticities of demand across the ten regions. Regions with high average elasticities of demand are likely to have high standard deviations in σ_{id} which reflects the high dispersions in demand elasticities across industries within one region.

7.3 Estimation of Productivity, Quality and Taste

Table 3 averages the estimated ω , δ and λ by region (in logs). While average productivity and quality of exported products are stable and robust across destinations, the average consumer taste for exported Belgian products varies substantially by destination. This confirms the notion that productivity and quality are firm-product level variables, chosen by the firm but that these product attributes do not vary much across destinations. Taste, however is destination specific and the last column in Table 3 indicates that taste of consumers for exported Belgian products varies substantially. The taste for Belgian export products varies substantially by destination. The taste parameter is always positive for any firm-product-destination flow as long as a product is present in a market.[39] If measurement error would determine our taste parameter, then there is no reason why it would vary by destination, suggesting it really reflects taste differences. For example, from Table 3 it can be noted that the average taste for Belgian products in China is higher than that in North America (NA).

The standard deviations of productivity and quality of Belgian products shipped to the different regions is small, whereas the standard deviation of the taste index is very large and about five times as high, which can be seen in Figure 1 and confirms the more idiosyncratic nature of taste e.g. products with the same productivity and quality may not be liked in every destination to the same extent. These standard variations will prove useful in order to understand decomposition results by region which we discuss later.

Table 4 provides us with correlations between the estimated parameters ω, δ and λ. The low correlation between what we identify as "taste" and firm-product productivity suggests that distribution networks are not contaminating our taste measure. If our taste would pick up the presence of distribution networks, we would expect a strong correlation between our taste variable and productivity since distribution networks require cost outlays (Arkolakis (2010)).

Our model does not predict a strong correlation between quality and productivity or between productivity and taste. In this context, when both quality and taste are introduced as demand shifters, even firms with low productivity but high taste for their products can generate high profits. This explains why our model does not predict a strong correlation between any of these variables. The data seem to confirm this. The correlation between productivity and quality is

[39]But note that the mean indices are expressed in logs which is why the taste index takes on a negative value in some regions.

positive but as small as 0.06.

The correlation between quality and taste in the data is even negative and around -0.16.[40] This suggests that firm-products with high tastes can be exported even when their product quality is not high.

7.4 Decomposition of firm-product Export Revenue

7.4.1 Consumer versus Intermediate Goods

In column (1) of Table 5, we report the regression coefficients on each of the components in the decomposition exercise. The regressions are at firm-product export revenue and each regression coefficient gives the percentage variation that it explains of the firm-product revenue. Since we are mainly interested in a decomposition of firm-product appeal, we focus on the coefficient of ω, δ and λ. It is clear that demand side factors (δ and λ) play an important role in explaining the variations in firm-product export revenue. Taste is the most important determinant in the decomposition (β_λ) and explains around 50% of the overall variation and appears much more important than quality (β_δ).

Productivity is important too and explains around one third of the variation in firm-product revenue. But productivity (β_ω) is less important than taste in explaining firm-product revenue. In column (2) of Table 5, we separate consumption goods from intermediate goods (column (3)) and find that for consumption goods, taste matters even more.[41]

The overwhelming importance of consumer taste in explaining firm export success is a new finding and its magnitude suggests that its importance cannot be overlooked. We defined consumer taste as a residual source of variation in the data after controlling for productivity and

[40]Since quality is measured at firm-product level and consumer taste is at product-destination level, in order to check the correlation among them we construct a firm-product level index for consumer tastes by simply calculating the average tastes across all destination countries that the firm-product pair exported to. Also each parameter is normalized to their industry(HS2) mean to control the heterogeneity in these indices across industries.

[41]The taste parameter for intermediate goods captures the taste of processing firms that are located farther downstream in the production process.

quality at firm-product level, but also controlling for market size and income of the destination, markups and competition effects that also vary by destination. Therefore, the estimated taste parameter is cleaned of all the usual suspects that offer alternative explanations for the variation in firm export revenue at the product level across destinations.

For completeness we show the full decomposition in Appendix B-2, including the percentage variation explained by the control variables (β_T) which tends to be small for both consumption and intermediate goods.

7.4.2 Goods with and without a Reference Prices

In Table 5, we also distinguish between goods that are exchanged on a market and have a reference price and those goods that are not and results of the decomposition are shown in columns (4) and (5) respectively. This classification is the one by Rauch (1999) to distinguish between homogeneous goods that are commonly traded on market exchanges and those that are too differentiated to have a reference price. Since we are mainly interested in a decomposition of firm-product appeal, we focus on the regression coefficients on ω, δ and λ. From the last row we observe that taste is a very important explanatory factor in explaining firm-product export revenue for both types of goods. Even for goods with a reference price ("homogeneous" goods), taste in the destination explains over 50% of the data variation in sales. For goods without a reference price ("differentiated" goods), taste is also the most important determinant in explaining firm-product export revenue. Although for goods without a reference price, we see that quality differentiation explains relatively more than for reference price goods.

In Rauch's classification, the "goods without a reference price" are typically considered to be the group of differentiated products, but the classification does not distinguish between the type of product differentiation. Put differently, Rauch does not distinguish between vertical and horizontal differentiation of goods. Our decomposition allows us to distinguish the two such that we can say that even for goods without a reference price, it is horizontal differentiation that seems to matter most in explaining export performance variation between products which we believe is a novel and interesting result.

Looking at results in the last two columns of Table 5 we note that firm heterogeneity is the main factor determining the export revenue variations across firm-product pairs in goods without a reference price. For homogeneous goods e.g. goods with a reference price, products have high degrees of substitutability and firm heterogeneity is less important for consumers. Consumer tastes on product varieties are the main factors in explaining firm-product export revenue variations for reference price goods. In the Appendix Table B-3 we combine the BEC and the Rauch classification, which does not alter the results.

7.4.3 Cost Elasticity of Quality

Since producing high-quality goods are costly, the magnitudes of the cost elasticities of product quality (γ in equation (3)) may also affect the roles of productivity, quality and tastes in explaining the variations of firm-product export revenue. Equation (4) indicates that the contribution of product quality (δ) to the export revenue depends on the scale of the cost elasticity of quality improvement. In the case of a small cost elasticity of quality improvement (i.e., $\gamma < \frac{1}{\sigma_{id}-1}$), high-quality products have high export revenue relative to low-quality goods. If the costs of producing high-quality goods are high ($\gamma > \frac{1}{\sigma_{id}-1}$), firms producing high-quality incur high marginal costs and thus charge high prices. High prices reduce the quantity demanded and thus decrease the export revenue that the firm has. We next separate firm-product pairs based on the scale of cost elasticity of quality improvement and examine the roles of productivity, quality and tastes in explaining the variations of firm-product export revenue.[42] In particular, firm-product pairs with $\gamma < \frac{1}{\sigma-1}$ are classified as low cost on quality improvement (low-γ) and firm-product pairs with $\gamma > \frac{1}{\sigma-1}$ are classified as high cost on quality improvement (high-γ).

Results in Table 6 show that ω_{ijt} is the most important determinant in explaining the

[42]Since σ_{id} varies across destinations, we use the weighted average σ that a firm-product pair face where σ_{id} is weighted by the share of export revenue in country d over total export revenue of a firm-product pair.

variation of export sales of goods for which the cost of quality is high, while for those with a low cost of quality, taste is a more important explanation.

In Tables B-4 and B-5 for completeness we document results of a decomposition of firm-product export revenue where we combine the BEC, Rauch and the magnitude of cost elasticity of quality improvement. In general productivity differences between firm-products become more prominent than taste in explaining export revenue variations for firm-product pairs with high cost elasticity of quality improvement.

7.5 Decomposition by Destination

Table 7 shows that firm-product appeal does not just vary by product type but also by destination. What has to be kept in mind is that for the identification of the taste parameter we required variation in export sales across destinations for the same product. But once taste is identified for each product-destination, we can turn to variation of taste across products within a destination which is what we do here in the decomposition. The results by destination lead us to conclude that the relative importance of demand versus supply components in export success, is destination-specific. While China displays a high average taste index for Belgian products (Table 3), the decomposition by destination shows that mainly quality differences between products is what explains export success in China. Despite high levels of taste for Belgian products, taste explains 31% (α_λ in Table 7) while quality explains 59% (α_δ) of variation in export revenues of firms in China. The relatively low percentage variation in revenues explained by taste suggests that there is less taste variation (a lower range of λs) amongst consumers on the Chinese market. This is very different for North-America where in the decomposition the taste regression coefficient is larger, referring to the fact that America consumers appear less "aligned" in their tastes e.g. both high and low quality goods sell well and tastes are more idiosyncratic (a larger range of λs). This conclusion does not depend on the product composition that is being shipped to each market as we will see in the next section.

In all regions we find quality and taste to be negatively correlated but in some more than in others as shown in Table 8. For example, in China we find a correlation of -0.07 and for North America the correlation is -0.2. This suggests that quality and taste are stronger substitutes in North-America than in China.

7.6 Robustness Checks

7.6.1 Balanced Panel Results

Table 9 shows a positive correlation between distance to destination and the minimum product quality present in a destination. We also find a positive correlation between distance and the minimum productivity at firm-product level. The positive correlations between distance to destination and the quality(productivity) threshold also hold if the 1 percentile of quality(productivity) index is used instead of the minimum level of quality(productivity) indices across firms within one destination. These results suggest that the threshold for quality and productivity rises with distance.[43] Finally, in column (5) of Table 9, we examine the correlation between the distance to destination and the minimum tastes index.[44] The positive correlation between distance and taste index suggests that firms are able to enter a destination far away from Belgium if consumers in that destination have a strong preference for Belgium products.

The patterns observed in Table 9 imply that product composition varies across destinations and that fewer products are shipped to more distant destinations, where only products that represent higher quality, higher productivity and stronger tastes are shipped. The structural model that we develop in this paper conditions on firms being present in a market and aims to explain differences in firm export revenues on the intensive margin but does not explicitly study entry into export markets. The results in Table 9 however suggest that when we decompose

[43] Baldwin and Harrigan (2011), Manova and Zhang (2012) find similar results.

[44] Since consumer tastes indices are at region-(HS4)product level, we calculate the average distance across countries within one region and then compare the correlation between the tastes indices with regional average distance.

cost, quality and taste determinants, as we do in the previous section, the results may be affected by a different product composition being present in each destination.

It can be verified that the results in Table 10 in a balanced panel are very similar to the ones in Table 5 where we included all observations. Therefore our earlier conclusions on the importance of taste versus other determinants in consumption versus intermediate type of goods are qualitatively the same which can be seen from the first two columns of Table 10. Also the results on the Rauch classification goods do not change in a balanced panel which can be seen from the last two columns in Table 10. Taste still remains a very important determinant in the decomposition of export revenue for both goods with and without a reference price. For goods without a reference price, horizontal differentiation remains the more important of the two demand variables ($\beta_\lambda > \beta_\delta$).

The decomposition by region results for a balanced panel are shown in Table 11. So while demand as opposed to productivity determines the majority of the variation in export success in every region, the relative importance of demand factors vary by destination. The results that we obtain on the decomposition by destination, do not depend on the product composition since we obtain similar results in a balanced panel in Table 11 as in the unbalanced panel in Table 7. For completeness we show in Appendix Table B-6, the full set of results on the decomposition by region in a balanced panel, including the control variables (N, INP, q_{j-i}, k) which are the variables whose effect is now captured in Table 11 by α_T. These remaining variables explain relatively little of the total variation in export sales, confirming that productivity, quality and taste are the most important determinants of firm export success.

7.6.2 Age of the Firm

Thus far, we have not explicitly accounted for the age of a firm e.g. for how long a firm-product has been present in a destination market. Could it be that firms that are present in a market already longer with their products, also sell more? Age effects should then be separated from taste. We thus perform a robustness check to make sure that our taste variable is not picking up firm-product age. In defining a measure of firm-product age, we drop the firm-(CN8)-product-region combinations that appear in the first year of our panel as for those firm-product-region combinations we have no information on how long they have been in the destination market e.g. we do not know their age.

An OLS regression of our taste measure on ln(age) results in a correlation of 0.4. However when we insert ln(age) as a separate regressor in the demand equation (7), the age variable does not show up as significant in the regression. The correlation of our taste variable in the models without and with age (whenever we have information on age), is around 0.89. This is reassuring and means that the ranking of our earlier taste index does not change much when controlling for the firm-product age in the demand function estimation. Taste with and without age included in the demand are plotted in Figure 2 for the food industry as an illustration, clearly showing the strong correlation between the two.

In additional to ln(age) we also experiment with including the interaction between D_{kgt} and ln(age) in the demand estimation (7), again ln(age) is not significant in the demand equation and the taste index remains intact.

7.6.3 Allocation of Inputs to Outputs

And finally, we run a robustness check on the allocation mechanism that we used in the estimation of productivity. In Section 5.2, we assigned firm-level inputs to outputs according to the product's revenue share in the firm to construct firm-product input usage for multiproduct firms. However, in the presence of varying markups at firm-product level, revenue share may not reflect output but variable markups instead. To assess our earlier allocation of inputs, we construct an alternative input allocation method. We first deflate every product's export revenue by its markup $(\sigma - 1)$ and then calculated the deflated revenue share of the products. Suppose a firm produces two products with the markups σ_1 and σ_2. We divide the sales revenue of these two products by their associated markups, $\tilde{R}_1 \equiv \frac{p_1 q_1}{(\sigma_1 - 1)}$ and $\tilde{R}_2 \equiv \frac{p_2 q_2}{(\sigma_2 - 1)}$. We then calculate the deflated output share for these two products where $\tilde{s}_1 \equiv \frac{\tilde{R}_1}{\tilde{R}_1 + \tilde{R}_2}$ and $\tilde{s}_2 \equiv \frac{\tilde{R}_2}{\tilde{R}_1 + \tilde{R}_2}$.

To obtain a σ_i for each product, we calculate the average of the estimated σ_{id} across regions within a (HS2) industry where $\sigma_i = \frac{1}{N_d} \sum_d \sigma_{id}$ and N_d is the number of regions in the data. Since we only estimate σ_i for eight industries, we assign the mean of σ_i (i.e., $\frac{1}{8} \sum_{i=1}^{8} \sigma_i$) across the eight industries to the associated σ for the rest of the industries as well as for the domestic sales. We then subsequently use the new sales share to estimate the revenue function in order to obtain our measure of ω (TFPQ).The correlation of productivity obtained in section 5.2 and the one obtained under the alternative allocation mechanism is very high (0.98). Thus the allocation rule of Foster et al. (2008) that we used initially was not too bad despite varying markups of products within the firm.

8 Conclusion

In this paper, we contribute to the growing literature on the demand-side factor, or "firm appeal", that has been shown to explain the bulk of firm success. In contrast to this literature, however, we disentangle "firm" appeal into its demand components using more disaggregated product-level data within firms. We identify consumer taste as a separate demand-side factor from product quality in explaining the export performance of firms. The destination-specific information on consumption for each firm-product allows for the identification of taste as a determinant in export revenues and distinguishes it from income, market size, markups and other destination related effects that may also explain differences in firm-product export sales.

Empirically we find that the standard deviations in average taste across products within a destination is up to five times as large as the standard deviations of the average quality and productivity of products present in a destination. When we perform a decomposition of firm product appeal in the spirit of Hottman et al. (2016), we find that taste typically accounts for 50% of the variation in export sales. Thus, a failure to account for taste results in a serious underestimation of the importance of the demand side and an overestimation of the supply side. For firm-product pairs with low cost elasticity of quality improvement, the role of tastes continue to be the most dominant in explaining variation in export sales (at 57%) with productivity and quality accounting for 8% and 10% respectively. However, for firm-product pairs with high cost of quality improvement, productivity differences become more prominent (at 47%) than tastes (at 39%) in explaining export success.

Our key finding that, of all the potential sources of firm-product heterogeneity that can generate differences across firms in their export success, the role of tastes dominates that of productivity and quality underlines the importance of firm learning about the demand side of the market. This is consistent with recent research on firm dynamics and the growth of new firms through "demand accumulation" emphasized by Foster, Haltiwanger and Syverson (2016) and "customer accumulation" by Eaton et al. (2015). In particular, Foster et al. (2016) show that the size gap between new businesses and established ones do not reflect productivity gaps but rather show differences in demand fundamentals.

The importance of demand-side factors and tastes in particular in explaining export success could offer one of many potential explanation for the wave of reshoring observed in recent years.[45] In relocating production from lower cost countries to a location closer to the final consumer is a recognition of the benefits of increased flexibility and speed in firms' response to any changes in consumer preferences and tastes.

The importance of the demand side and of consumer taste in particular can also explain recent research documenting the greater prevalence of product innovation than process innovation (Van Beveren and Vandenbussche (2010)). Process innovation is typically associated with a reduction in marginal cost whereas product innovation entails the introduction of new products which typically reflects a demand-side factor. Peters, Roberts, Vuong and Fryges

[45]The Economist, "Moving back to America", March 12 2011, http://www.economist.com/node/18682182.

(2017) find that among German firms, product innovation is concentrated in high-technology industries.

More generally, recent efforts in macro-economic modeling has shown that introducing consumer heterogeneity in terms of wealth and earnings inequality or discount factors (Ghironi, İşcan, and Rebucci (2008)) can have an important impact on aggregate outcomes. Taste heterogeneity among consumers, a phenomenon that we find to be very important in driving export success, could potentially have important macro-economic implications if incorporated in macro models.

Overall, this paper represents a first step toward a detailed understanding of how underlying firm heterogeneity on both the demand and production sides influence the success of Belgium manufacturing exporters. We demonstrate that this can be done by anyone with access to customs data and firm production data. Our results show that quantifying the sources of heterogeneity contributes immensely to our understanding about how exporting firms can compete with low-cost supplying countries that exploiting the role of demand in the form of learning about consumer taste in a destination market can impact profitability in that market. The next step is to introduce firm dynamics into our framework and incorporate entry and exit of firms in the export market and allow firms to invest in R&D or physical capital in order to impact their productivity, product quality or learn about consumer tastes.

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Table 1: Export Price and Quantity Variation: goodness-of-fit (R-squared)

	All Industries	
	lnp	**lnq**
Firm FE	0.519	0.415
Firm-Product	0.747	0.594
Product FE	0.429	0.286
Product-Country	0.502	0.372
Product - Region	0.434	0.290
Product Category - Country	0.366	0.240
Region	0.017	0.013
Year	0.002	0.001

Table 2: Demand Elasticity by Region and Industry

	Food	**Chemicals**	**Chemical Product**	**Plastic**	**Iron& Steel**	**Machi nery**	**Electrical &Electronic**	**Vehicle**	**Mean**	**S.D.**
AU	1.838	4.694	1.605	2.396	4.052	3.179	2.974	3.585	3.040	1.069
CN	1.678	3.405	2.216	1.580	5.424	4.005	7.835	3.684	3.728	2.105
EA	1.409	3.639	2.111	1.903	3.723	3.086	4.044	2.717	2.829	0.956
EE	1.903	3.837	2.613	2.627	5.056	4.489	4.778	2.940	3.530	1.168
ME	1.794	3.985	2.581	2.737	4.999	3.714	5.582	3.038	3.554	1.276
NA	1.698	2.520	1.845	1.836	3.854	3.418	3.123	2.077	2.546	0.823
SA	0.647	3.162	2.692	1.629	5.559	3.285	1.714	4.281	2.871	1.573
SAM	1.664	3.222	2.290	2.601	4.623	3.412	5.490	4.723	3.503	1.333
SSA	2.014	3.361	2.369	3.052	4.355	4.110	1.873	1.967	2.888	0.986
WE	2.435	3.745	2.888	2.600	6.195	4.184	5.235	4.131	3.926	1.313
Mean	1.708	3.557	2.321	2.296	4.784	3.688	4.265	3.314	3.242	
S.D.	0.460	0.577	0.396	0.516	0.807	0.483	1.898	0.926	0.461	

Note: All our estimated elasticities arise from the demand specification in (7). They are all significant at the 1% level which suggests a strong correlation of the instrument for price. In all demand regressions the correlation of the instrument with the residuals is either low or not significant.
There are ten regions:Australia(AU), China(CN), East Asia(EA), East Europe(EE), Middle East(ME), North America(NA), South Asia(SA), South America(SAM), Africa(SSA), West Europe(WE).

Table 3: Summary of Index in Productivity, Quality and Tastes

	mean($ln\omega$)	mean($ln\delta$)	mean($ln\lambda$)
AU	3.860	4.793	0.575
CN	3.269	4.898	2.112
EA	3.411	4.496	0.424
EE	3.323	4.574	-0.193
ME	3.332	4.550	0.381
NA	3.535	4.426	0.648
SA	3.210	5.163	-0.952
SAM	3.328	4.666	0.538
SSA	3.434	4.616	0.570
WE	2.870	4.414	-0.629

Table 4: Correlation Matrix among Quality, Productivity and Tastes Indices

	$ln\delta$	$ln\omega$	$ln\lambda$
$ln\delta$	1		
$ln\omega$	0.0625	1	
$ln\lambda$	-0.1648	0.2191	1

Note: All variables are normalized to their (HS2)industry mean levels.
Consumer tastes are constructed at firm-product level where firm-product consumer tastes are the mean of consumer tastes across destinations that the firm-product export to.

Table 5: Decomposition of Firm-Product Revenue (BEC and Rauch classification)

	BEC			Rauch	
	Overall	**Consumption goods**	**Intermediates**	**reference price**	**no reference price**
β_T	0.1414***	-0.0600***	0.2097***	0.0914***	0.1463***
	(0.004)	(0.009)	(0.005)	(0.007)	(0.005)
β_ω	0.3011***	0.4318***	0.2882***	0.2498***	0.3636***
	(0.003)	(0.006)	(0.004)	(0.005)	(0.004)
β_δ	0.0803***	0.0975***	0.0879***	0.0690***	0.0942***
	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)
β_λ	0.4772***	0.5307***	0.4142***	0.5898***	0.3960***
	(0.003)	(0.007)	(0.004)	(0.006)	(0.004)
no.(obs)	51,449	11,139	25,535	17,391	28,436

Note: We use the BEC classification to identify consumption and intermediate goods in our data.

Table 6: Decomposition of Firm-Product Revenue, by cost of quality improvement

	Low cost on quality improvement	**High cost on quality improvement**	**Overall**
β_T	0.2462***	0.0876***	0.1414***
	(0.007)	(0.005)	(0.004)
β_ω	0.0815***	0.4724***	0.3011***
	(0.003)	(0.004)	(0.003)
β_δ	0.1022***	0.0534***	0.0803***
	(0.002)	(0.002)	(0.001)
β_λ	0.5701***	0.3867***	0.4772***
	(0.005)	(0.004)	(0.003)
no.(obs)	22,293	29,156	51,449

Note:: Low cost of quality improvement: Firm-(CN8)product pairs with $1-(\bar{\sigma}-1)\times\gamma \geq 0$, where $\bar{\sigma}$ is the average sigma across all destinations that the firm's product export to. High cost of quality improvement: Firm-(CN8)product pairs with $1-(\bar{\sigma}-1)\times\gamma < 0$.

Table 7: Decomposition of Firm-Product-Region Revenue, by Region

	Australasia (AU)	China (CN)	East Asia (EA)	East Europe (EE)	Middle East (ME)
α_T	0.0140***	0.0043*	0.0116***	0.1449***	0.1593***
	(0.002)	(0.002)	(0.001)	(0.004)	(0.004)
α_ω	0.0861***	0.0854***	0.0280***	0.2509***	0.1707***
	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)
α_δ	0.8575***	0.5982***	0.3038***	0.1506***	0.1838***
	(0.011)	(0.010)	(0.002)	(0.003)	(0.004)
α_λ	0.0423***	0.3121***	0.6566***	0.4536***	0.4862***
	(0.010)	(0.010)	(0.003)	(0.004)	(0.005)
no.(obs)	3,287	2,182	8,295	16,759	10,597
	North America (NA)	South Asia (SA)	South America (SAM)	Africa (SSA)	West Europe (WE)
α_T	0.0133***	0.0384***	0.0640***	0.0514***	0.0884***
	(0.002)	(0.004)	(0.004)	(0.004)	(0.002)
α_ω	0.1369***	0.0758***	0.1027***	0.0593***	0.2841***
	(0.003)	(0.005)	(0.004)	(0.005)	(0.002)
α_δ	0.1879***	0.7472***	0.1683***	0.2868***	0.2233***
	(0.007)	(0.013)	(0.003)	(0.006)	(0.001)
α_λ	0.6619***	0.1386***	0.6650***	0.6026***	0.4042***
	(0.008)	(0.013)	(0.005)	(0.007)	(0.002)
no.(obs)	7,594	2,569	6,402	5,214	49,167

Table 8: Correlation between Quality and Tastes indices, by Region

	Corr(Quality, Tastes)
AU	-0.1307
CN	-0.0766
EA	-0.1753
EE	-0.1922
ME	-0.1899
NA	-0.1912
SA	-0.1000
SAM	-0.1400
SSA	-0.2115
WE	-0.1908

Table 9: Minimum quality(productivity) in each country v.s. Distance from Belgium

	Minimum Quality Index	**Quality Index at 1%**	**Minimum Productivity Index**	**Productivity Index at 1%**	**Minimum Tastes Index**
ln(Distance)	0.224	0.369	0.513	0.606	0.89
	(0.010)***	(0.010)***	(0.010)***	(0.011)***	(0.094)***
Year dummy	yes	yes	yes	yes	yes
(HS2)Industry Dummy	yes	yes	yes	yes	yes
no.(obs.)	8,452	8,452	8,451	8,451	640

Table 10: Decomposition of Firm-Product Revenue (BEC and Rauch classification)

	Balanced Panel			
	BEC		Rauch	
	Consumption goods	**Intermediates**	**reference price**	**no reference price**
β_T	-0.1044***	0.2194***	0.1801***	0.0744***
	(0.017)	(0.012)	(0.015)	(0.012)
β_ω	0.3879***	0.3273***	0.1520***	0.4787***
	(0.014)	(0.009)	(0.010)	(0.009)
β_δ	0.1499***	0.1588***	0.1145***	0.1716***
	(0.009)	(0.005)	(0.006)	(0.006)
β_λ	0.5666***	0.2946***	0.5534***	0.2753***
	(0.014)	(0.007)	(0.010)	(0.007)
no.(obs)	2,351	6,655	3,917	6,602

Table 11: Decomposition of Firm-Product-Region Revenue, by Region on Balanced Panel

	Australasia (AU)	China (CN)	East Asia (EA)	East Europe (EE)	Middle East (ME)
α_T	0.0204***	0.0016	0.0178***	0.1573***	0.2398***
	(0.003)	(0.003)	(0.003)	(0.008)	(0.010)
α_ω	0.0898***	0.0828***	0.0348***	0.2776***	0.2949***
	(0.005)	(0.005)	(0.004)	(0.008)	(0.010)
α_δ	0.8606***	0.6419***	0.3226***	0.0719***	0.0458***
	(0.012)	(0.011)	(0.004)	(0.005)	(0.008)
α_λ	0.0292***	0.2736**	0.6249***	0.4932***	0.4195***
	(0.011)	(0.011)	(0.005)	(0.008)	(0.010)
no.(obs)	1,810	1,444	3,217	5,169	3,726
	North America (NA)	South Asia (SA)	South America (SAM)	Africa (SSA)	West Europe (WE)
α_T	0.0184***	0.0248***	0.0989***	0.0585***	0.0834***
	(0.004)	(0.005)	(0.009)	(0.008)	(0.004)
α_ω	0.1842***	0.0989***	0.1785***	0.1204***	0.2736***
	(0.007)	(0.008)	(0.009)	(0.009)	(0.005)
α_δ	0.1936***	0.8100***	0.1602***	0.2757***	0.2307***
	(0.013)	(0.019)	(0.007)	(0.011)	(0.003)
α_λ	0.6037***	0.0663***	0.5625***	0.5454***	0.4122***
	(0.016)	(0.018)	(0.010)	(0.011)	(0.004)
no.(obs)	2,975	1,376	2,573	2,212	10,838

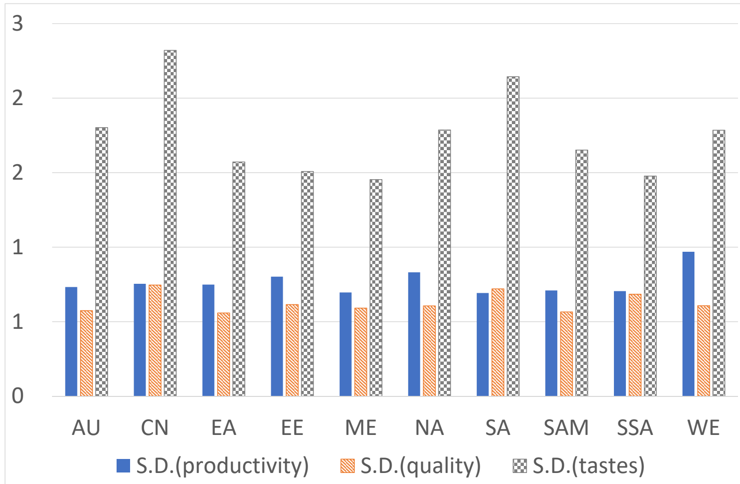

Figure 1: Standard Deviation of Productivity, Quality and Taste (average indices) by Region

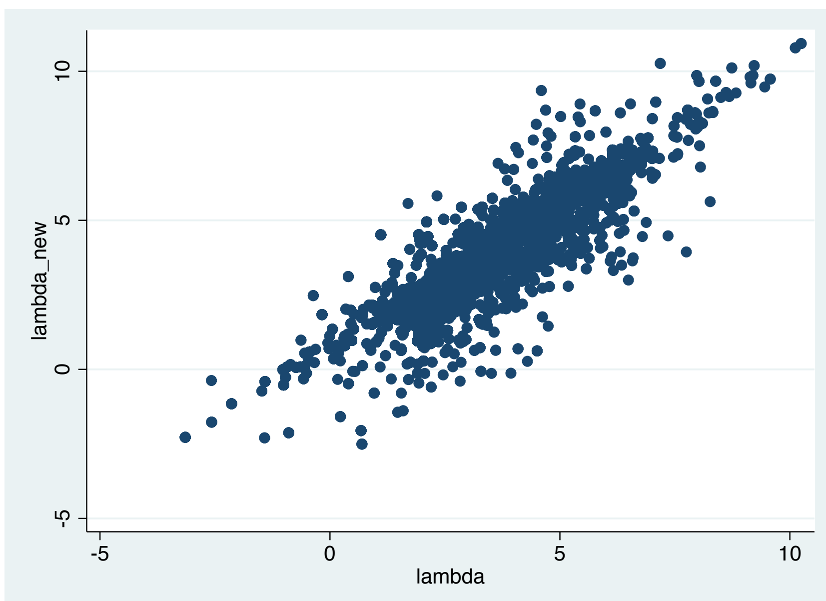

Figure 2: Scatter Plot between Taste Index without and with Controlling Firm-Product Age in Demand Function, Food Industry

Appendix A

In order to construct each component on the right-hand side of equation (13) at the firm-product level we rewrite equation (13):

$$\tilde{r}_{jidt}^{\frac{1}{1-\sigma_{id}}} = \delta_{jit}^{(\frac{1}{1-\sigma_{id}}+\gamma_\delta)} \lambda_{kgt}^{\frac{1}{1-\sigma_{id}}} \omega_{jit}^{-1} INP_{jt}^{\gamma_{inp}} k_{jt}^{\gamma_k} q_{j-it}^{\gamma_q} \tag{A.1}$$

It is clear from equation (A.1) that in aggregating export revenues across destination markets, it is necessary to construct firm-product level quality and tastes indices ($\tilde{\delta}$ and $\tilde{\lambda}$ in below) that controls for the variance in quality and tastes across regions.

Rearranging equation (A.1), firm j's total export revenues on product i across all destination countries can be expressed as:

$$\begin{aligned} r_{jit} \equiv \sum_d \tilde{r}_{jidt}^{\frac{1}{1-\sigma_{id}}} &= \sum_d \delta_{jit}^{(\frac{1}{1-\sigma_{id}}+\gamma_\delta)} \lambda_{kgt}^{\frac{1}{1-\sigma_{id}}} \omega_{jit}^{-1} INP_{jt}^{\gamma_{inp}} k_{jt}^{\gamma_k} q_{j-it}^{\gamma_q} \\ &= \left[\frac{1}{N_{jit}^d} \sum_d \left(\frac{\delta_{jit}^{(\frac{1}{1-\sigma_{id}}+\gamma_\delta)}}{\widetilde{\delta_{jit}}}\right)\left(\frac{\lambda_{kgt}^{\frac{1}{1-\sigma_{id}}}}{\widetilde{\lambda_{jit}}}\right)\right] N_{jit}^d \widetilde{\delta_{jit}} \widetilde{\lambda_{jit}} \omega_{jit}^{-1} INP_{jt}^{\gamma_{inp}} k_{jt}^{\gamma_k} q_{j-it}^{\gamma_q} \end{aligned} \tag{A.2}$$

where $\widetilde{\lambda_{jit}} = \left(\Pi_{k,g \in D_{ijt}^d} \lambda_{kgt}^{\frac{1}{1-\sigma_{id}}}\right)^{1/N_{jit}^d}$ is the geometric mean of consumer tastes across all destinations that a firm-product pair exports[46] and D_{ijt}^d [47] represents the set of (HS4)product-region pairs that firm j export product i to country d in year t and N_{jit}^d is the number of destination countries that the firm-product pair exported to. $\widetilde{\delta_{jit}} = \left(\Pi_d \delta_{jit}^{\frac{1}{1-\sigma_{id}}+\gamma_\delta}\right)^{1/N_{jit}^d}$ is the geometric mean of firm-product quality weighted by the elasticity of demand across all destinations.

[46]The data forces us to structurally identify λ at a more aggregate product-level and destination e.g. HS4-region. These values are then used to construct a λ (taste) parameter at the more disaggregate firm-CN8 level.

[47]Two firms selling same CN8 products will have different taste values assigned to them, provided they differ in their set of export destinations.

Taking logs of equation (A.2), we get

$$lnr_{jit} = ln\underbrace{\left[\frac{1}{N_{jit}^{d}}\sum_{d}\left(\frac{\delta_{jit}^{(\frac{1}{1-\sigma_{id}}+\gamma_{\delta})}}{\widetilde{\delta_{jit}}}\right)\left(\frac{\lambda_{kgt}^{\frac{1}{1-\sigma_{id}}}}{\widetilde{\lambda_{jit}}}\right)\right]}_{B_{jit}} + lnN_{jit}^{d} + ln\widetilde{\delta_{jit}} + ln\widetilde{\lambda_{jit}} - ln\omega_{jit}$$

$$+ \gamma_{inp}lnINP_{jt} + \gamma_{k}lnk_{jt} + \gamma_{q}lnq_{j-it} \tag{A.3}$$

where term B_{jit} captures the variation of weighted product quality and consumer tastes across all destinations that the firm-product exports to which includes two components: the variation in weighted product quality $\left(\frac{\delta_{jit}^{(\frac{1}{1-\sigma_{id}}+\gamma_{\delta})}}{\widetilde{\delta_{jit}}}\right)$ and the consumer tastes variation across (HS4)product and regions within a firm-product pair ji $\left(\frac{\lambda_{kgt}^{\frac{1}{1-\sigma_{id}}}}{\widetilde{\lambda_{jit}}}\right)$.

Appendix B

Table B-1: Number of firm-product-region observations in the subsamples

1. By HS2-Industry				
	Not export to all regions	Exported to all regions	Total	Share of no.(firm-product-region) exporting to all regions
Food	15,826	5,156	20,982	24.57
Chemicals	11,971	7,072	19,043	37.14
Chemical Product	9,623	9,010	18,633	48.36
Plastic	9,149	7,293	16,442	44.36
Iron&Steel	9,957	2,483	12,440	19.96
Machinery	11,681	2,776	14,457	19.20
Electricals&Electronics	5,833	438	6,271	6.98
Vehicle	2,686	1,112	3,798	29.28
Total	76,726	35,340	112,066	31.53
2. By Region				
	Not export to all regions	Exported to all regions	Total	Share of no.(firm-product-region) exporting to all regions
Australia(AU)	1,477	1,810	3,287	55.07
China(CN)	738	1,444	2,182	66.18
East Asia(EA)	5,078	3,217	8,295	38.78
East Europe(EE)	11,590	5,169	16,759	30.84
Middle East(ME)	6,871	3,726	10,597	35.16
North America(NA)	4,619	2,975	7,594	39.18
South Asia(SA)	1,193	1,376	2,569	53.56
South America(SAM)	3,829	2,573	6,402	40.19
Africa(SSA)	3,002	2,212	5,214	42.42
West Europe(WE)	38,329	10,838	49,167	22.04
Total	76,726	35,340	112,066	31.53

Table B-2: Decomposition of Firm-Product Revenue in eight Determinants

	Unbalanced Panel		
	Overall	**Consumption goods**	**Intermediates**
β_B	-0.0432***	-0.1017***	-0.0166***
	(0.002)	(0.006)	(0.002)
β_N	0.1624***	0.0228***	0.1968***
	(0.003)	(0.005)	(0.004)
β_W	0.0019	0.0209***	-0.0063***
	(0.002)	(0.003)	(0.002)
β_q	0.0157***	-0.0065	0.0320***
	(0.002)	(0.005)	(0.002)
β_k	0.0045***	0.0045***	0.0039***
	(0.000)	(0.001)	(0.001)
β_ω	0.3011***	0.4318***	0.2882***
	(0.003)	(0.006)	(0.004)
β_δ	0.0803***	0.0975***	0.0879***
	(0.001)	(0.003)	(0.002)
β_λ	0.4772***	0.5307***	0.4142***
	(0.003)	(0.007)	(0.004)
no.(obs)	51,449	11,139	25,535

Table B-3: Decomposition of Firm-Product Revenue, by product category(BEC & Rauch (liberal) classification)

	Balanced Panel			
	Consumption goods		**Intermediates**	
	reference price	**no reference price**	**reference price**	**no reference price**
β_B	-0.1808***	-0.1201***	-0.0399***	-0.0880***
	(0.038)	(0.011)	(0.005)	(0.006)
β_N	0.0400*	-0.0116	0.3158***	0.1250***
	(0.023)	(0.014)	(0.016)	(0.014)
β_W	-0.0268*	0.0228***	-0.0022	-0.0044
	(0.015)	(0.008)	(0.005)	(0.007)
β_q	0.0618***	0.0668***	-0.0009	0.0488***
	(0.020)	(0.011)	(0.005)	(0.007)
β_k	0.0012	0.0012	-0.0061***	-0.0003
	(0.002)	(0.001)	(0.003)	(0.002)
β_ω	0.1695***	0.6494***	0.1425***	0.4994***
	(0.030)	(0.016)	(0.014)	(0.013)
β_δ	0.1091***	0.2266***	0.1587***	0.1804***
	(0.015)	(0.012)	(0.008)	(0.008)
β_λ	0.8270***	0.1648***	0.4320***	0.2392***
	(0.034)	(0.010)	(0.012)	(0.009)
no.(obs)	417	1,934	2,320	3,690

Table B-4: Decomposition of Firm-Product Revenue, by cost of quality improvement & (BEC)

	Consumption goods		**Intermediates**	
	Low cost on quality improvement	**High cost on quality improvement**	**Low cost on quality improvement**	**High cost on quality improvement**
β_B	-0.0932***	0.0198***	-0.0157***	-0.0187***
	(0.012)	(0.003)	(0.004)	(0.002)
β_N	0.1111***	0.0572***	0.3278***	0.0925***
	(0.008)	(0.005)	(0.006)	(0.006)
β_W	0.0037	0.0276***	0.0009	-0.0118***
	(0.006)	(0.005)	(0.002)	(0.003)
β_q	0.0035	-0.0126**	0.0017	0.0559***
	(0.008)	(0.006)	(0.002)	(0.003)
β_k	0.0013*	0.0048***	0.0103***	-0.0011
	(0.001)	(0.001)	(0.001)	(0.001)
β_ω	0.1719***	0.5815***	0.0265***	0.4969***
	(0.010)	(0.007)	(0.004)	(0.006)
β_δ	0.1013***	0.0473***	0.1236***	0.0609***
	(0.007)	(0.003)	(0.003)	(0.003)
β_λ	0.7003***	0.2743***	0.5249***	0.3255***
	(0.014)	(0.006)	(0.006)	(0.005)
no.(obs)	3,585	7,554	11,465	14,070

Table B-5: Decomposition of Firm-Product Revenue, by cost of quality improvement, combined with Rauch-classification

	reference price		no reference price		Overall	
	Low cost on quality improvement	**High cost on quality improvement**	**Low cost on quality improvement**	**High cost on quality improvement**	**Low cost on quality improvement**	**High cost on quality improvement**
β_B	-0.0815***	-0.0598***	-0.0212***	-0.0232***	-0.0427***	-0.0256***
	(0.006)	(0.003)	(0.006)	(0.002)	(0.004)	(0.002)
β_N	0.2501***	0.0091	0.2567***	0.1068***	0.2747***	0.0853***
	(0.007)	(0.007)	(0.007)	(0.005)	(0.004)	(0.004)
β_W	-0.0021	0.0234***	-0.0112***	0.0035	-0.0057***	0.0060***
	(0.003)	(0.005)	(0.003)	(0.003)	(0.002)	(0.002)
β_q	0.0105***	-0.0217***	0.0148***	0.0358***	0.0128***	0.0198***
	(0.003)	(0.006)	(0.004)	(0.003)	(0.002)	(0.003)
β_k	0.0131***	0.0065***	0.0001	0.0003	0.0071***	0.0021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
β_ω	0.0731***	0.4887***	0.1082***	0.4957***	0.0815***	0.4724***
	(0.005)	(0.008)	(0.006)	(0.005)	(0.003)	(0.004)
β_δ	0.0797***	0.0547***	0.1395***	0.0596***	0.1022***	0.0534***
	(0.003)	(0.003)	(0.004)	(0.002)	(0.002)	(0.002)
β_λ	0.6570***	0.4992***	0.5131***	0.3214***	0.5701***	0.3867***
	(0.008)	(0.008)	(0.007)	(0.004)	(0.005)	(0.004)
no.(obs)	10,003	7,388	8,865	19,571	22,293	29,156

Table B-6: Decomposition of Firm-Product-Region Revenue, by Region on Balanced Panel

	Australasia (AU)	China (CN)	East Asia (EA)	East Europe (EE)	Middle East (ME)
α_N	0.0016		0.0099***	0.1286***	0.1444***
	(0.001)		(0.001)	(0.003)	(0.004)
α_W	0.0335***	0.0065**	-0.0044***	-0.0099***	-0.0211***
	(0.003)	(0.003)	(0.001)	(0.002)	(0.003)
α_q	-0.0257***	-0.0045	0.0061***	0.0227***	0.0341***
	(0.004)	(0.003)	(0.001)	(0.003)	(0.003)
α_k	0.0046***	0.0023***	0.0001	0.0035***	0.0019**
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
α_ω	0.0861***	0.0854***	0.0280***	0.2509***	0.1707***
	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)
α_δ	0.8575***	0.5982***	0.3038***	0.1506***	0.1838***
	(0.011)	(0.010)	(0.002)	(0.003)	(0.004)
α_λ	0.0423***	0.3121***	0.6566***	0.4536***	0.4862***
	(0.010)	(0.010)	(0.003)	(0.004)	(0.005)
no.(obs)	3,287	2,182	8,295	16,759	10,597
	North America (NA)	**South Asia (SA)**	**South America (SAM)**	**Africa (SSA)**	**West Europe (WE)**
α_N	0.0032***	0.0158***	0.0604***	0.0464***	0.0731***
	(0.001)	(0.003)	(0.004)	(0.004)	(0.002)
α_W	0.0075***	-0.0299***	-0.0108***	-0.0214***	0.0088***
	(0.002)	(0.004)	(0.003)	(0.003)	(0.001)
α_q	-0.0023	0.0464***	0.0152***	0.0272***	0.0024*
	(0.003)	(0.004)	(0.003)	(0.004)	(0.001)
α_k	0.0049***	0.0061***	-0.0008	-0.0007	0.0041***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
α_ω	0.1369***	0.0758***	0.1027***	0.0593***	0.2841***
	(0.003)	(0.005)	(0.004)	(0.005)	(0.002)
α_δ	0.1879***	0.7472***	0.1683***	0.2868***	0.2233***
	(0.007)	(0.013)	(0.003)	(0.006)	(0.001)
α_λ	0.6619***	0.1386***	0.6650***	0.6026***	0.4042***
	(0.008)	(0.013)	(0.005)	(0.007)	(0.002)
no.(obs)	7,594	2,569	6,402	5,214	49,167

Table B-7: Structure of the Combined Nomenclature (CN8) Classification

Combined Nomenclature 8-digit (CN8)		Harmonized System 6-digit (HS6)
Year	no. of CN8 products	
1988	9506	HS6 1988 (no. HS6 = 5019)
1989	9579	
1990	9695	
1991	9743	
1992	9837	HS6 1992 (no. HS6 = 5018)
1993	9906	
1994	10108	
1995	10448	
1996	10495	HS6 1996 (no. HS6 = 5113)
1997	10606	
1998	10587	
1999	10428	
2000	10314	
2001	10274	
2002	9837	HS6 2002 (no. HS6 = 5224)
2003	9906	
2004	10108	
2005	10448	
2006	9841	
2007	9720	HS6 2007 (no. HS6 = 5051)
2008	9699	
2009	9569	
2010	9443	

Notes: All classification files are obtained from the Eurostat Ramon server, with the exception of the files for 1988-1994, which were provided by Eurostat on request.

Table B-8: Structural Parameters of Interest Identified in the Model

Parameters Identified	In the Theory varies at	In the Empirics varies at
σ_{id}	product i, destination d level	HS2-Region level
λ_{idt}	product i, destination d level and year t	HS4-Region-year level
δ_{jit}	firm(j)-product(i) and year t	firm-CN8-year level
ω_{jit}	firm(j)-product(i) and year t	firm-CN8-year level